EFFECTIVENESS OF CYCLONE TUNNELS AS TOILET VENTILATOR FOR GREEN ARCHITECTURE

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Abstract. Highest usage of energy to the air condition will be ever accompanied by the increasing of Glass house Gas productivity, owning flimsy impact of Ozone coat in Atmosphere. Really this phenomenon in future will be more concern, the important thing in city area that loaded high rise building. For that to all architects along with their stakeholder who required doing the effort accompanied with variety of innovation and also creation that based on action of energy economically. Existence of Structure System of Core at laminated building of many floors (high rise building) where the shape was looked like flue roof boosting to follow height of building, can be processed and dimulty functioned as component of natural evaporation system by giving addition some elements among others, mow (duct) vertical - horizontal, room or funnel for cross section of temporary air, baling-baling (cyclone) and grill. With this natural evaporation method, the assumption can do to transfer of air at least at restroom or toilet area at high rise. Functionalism of core was as flue of natural evaporation meant as adding effort on exchequer of Green Architecture.

Keyword: economical of energy, gas of glass house, green architecture

Abstrak

Semakin tingginya penggunaan energi untuk pengkondisian udara, akan senantiasa diiringi oleh meningkatnya produktivitas Gas Rumah Kaca, yang memiliki dampak menipisnya lapisan Ozon di Atmosfir. Sungguh fenomena ini kedepan akan semakin memprihatinkan, utamanya di kawasan perkotaan yang sarat bangunan tinggi. Untuk itu bagi para arsitek beserta steakholder-nya perlu melakukan upaya yang diiringi dengan ragam inovasi serta kreasi yang berbasis pada tindakan hemat energi. Keberadaan Sistem Struktur Core pada bangunan berlapis lantai banyak (high rise building) dimana bentuknya telah menyerupai bumbung cerobong yang menjulang mengikuti ketinggian bangunan, dapat diolah dan dimulti fungsikan sebagai komponen Sistem penghawaan alamiah dengan memberikan tambahan beberapa elemen diantaranya, selumbung (duct) vertikal – horizontal, ruang atau corong penampung udara sementara, bailng-baling (cyclone) dan kisi-kisi (grill). Dengan metoda penghawaan alamiah ini, diasumsi dapat melakukan pertukaran udara sedikitnya pada area lantai dasar untuk gedung empat lantai keatas. Fungsionalisasi core sebagai cerobong penghawaan alamiah dimaksudkan sebagai upaya penambah perbendaharaan Green Architecture.

Kata kunci: Arsitektur hijau, Gas rumah kaca, Hemat energi

INTRODUCTION

When we contemplate deeply about the existence of the Tropical Climate in the Equatorial region, where the Earth Belt around which is always bathed in the Sun Light, then implies the storage of abundant energy in the Earth's Stomach. Truly it all is thanks to the grace and grace of God Almighty, who presumably deserves to be continually grateful for its existence. Factors that greatly affect the comfort of tropical climates, especially the Moist Tropics, such as the Nusantara Region, are temperature and humidity. Brightness that is felt on the surface of human skin is caused by the difficulty of evaporation due to relative humidity in the air around the body, where the water vapor content reaches 40% to 70%.

By lowering the two factors above, there will be a gradation of increased comfort felt by residents who live in a building, this formula is the basis for the creation of an active air conditioning device.

As an excess of this phenomenon in the middle circumference of the earth it has a relatively hot ambient temperature, coupled with the vast area of water which naturally also occurs high evaporation. So in the passive air cooling system, one component of natural phenomena that is commonly taken into account is the existence of wind, although its presence in the archipelago is not too fast.

Wind is a potential factor that is not a concern, in building technology engineering activities. Therefore in this paper the wind is used as a determining factor for the success of passive air cooling efforts.

This notion is actually a continuation of the research by the author of "Chimney House as the Optimization of Cross Ventilation", but in this study it is specifically intended for homes that are horizontally single-layered. When one focuses on the environmental quality of building, ventilation is essential for sanitary reason to maintain acceptable levels of indoor air quality by removing pollutants [1].

The problems of natural ventilation in crowded urban buildings include:

- Non-fulfillment of the Basic Building Coefficient (KDB) maximum of 60%, so there is not enough land available for building breathing.
- There is no air movement, even though the opening side is available on one surface of the building, because the opening properties are not intermittent with the opening on the other side of the surface, so it does not have an air outlet (out let). Bearing in mind that as a condition of air movement, if the building has air inlets and outlets, crossing ventilation occurs. On the other hand, because there is a distance between buildings or spaces that coincide it is not possible to make an outlet hole.
- Low quality of air around the area that supplies for inlet needs [2].

METHODOLOGY

In his book "Tropenbau Building in Tropic" Georg Lippsmeir, 1980 revealed that in addition to the factors of sunlight radiation, temperature and humidity, air / wind movement factors also significantly influence thermal comfort. Even the wind can also reduce air humidity [3].

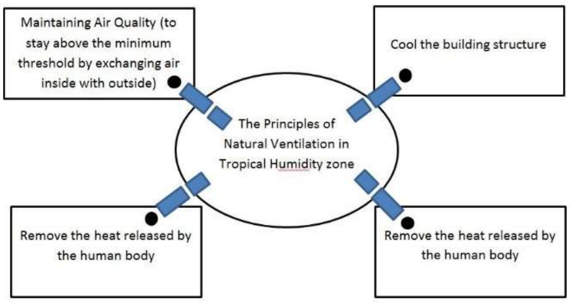

FIGURE 1. The principle of natural ventilation in dry tropical humidity areas [4].

Mas Santoso, 1996, in the International Association for the Study of Traditional Environments forum, at the University of California, Barkley presented his paper "Environmental Factors in Traditional Environment", that the potential wind generated by air movement, can be considered as a passive cooling, in order to overcome thermal discomfort. According to the conditions in Surabaya, it can be ascertained that physically the existence of temperature in one year is the same, it is due to the very thin variations in the season.Climate in Indonesia (Surabaya), human needs in terms of heat in buildings will be satisfactory by carefully designing building construction. As for the things that need to be done are:

1. Prevent prolonged direct solar radiation.
2. Prevent internal temperature elevation.
3. Comply with the provisions of efficient ventilation systems [5].

The results indicate that cross ventilation has the best ventilation performance and the situation for opening on the leeward wall is better than that on the windward wall [6].

Wind can be classified as a physiological cooling device. Wind produced by the movement of air, is the only thing that makes it possible to realize a passive cooling system (passive cooling system), in an area with hot humid climates. The wind is quite fast speed, often needed also in the cooling process, so that it can cause comfort. This is appropriate in conditions of high air temperatures. The movement of air can produce wind energy that can be used to operate work equipment. The occurrence of wind due to the heat of the sun that warms the air so that there is some lighter air then rises (there is a stack effect), then there is a void of air in certain areas, to be immediately filled by other parts of the air that are more dense (wind). The wind can have energy content that can be utilized to drive work equipment.

This effort is intended to provide additional insight that the thermal discomfort problem should not be solved actively by using air conditioning which in the end will actually reduce the quality of microclimate in tropical cities so that it becomes even more uncomfortable as an area for daily activities.

making the continued increase in energy needs in urban zones. According to the results of the Association of Building Physics Experts (IAFBI), in 2008 in the DKI Jakarta area there were 960,000 buildings and 1,000 of them were on a 5-story floor, while 571 eight-story buildings were used as research objects, only about 10% or only 50 buildings in Jakarta, which uses energy close to the standard.

The wind is very useful, it can be proven through the average evaporation of air humidity, depending on the movement of air, that's why there is a good wind flow in the air outside or air inside the room, for the building is very useful. In the condition of buildings that are grouped, the orientation and distance of the trainees far between buildings will contribute to the attack on the air circulation system. Regarding this matter, Arthur Bowen revealed that, one of the characteristics of settlements in Indonesia is that they pay close attention to the above issues. Even more important is the distribution of air flow is very dependent on the geometric shape of the environment and the building itself.

The minimum air velocity required, indicates that buildings under ordinary conditions, ie buildings that are classified as open type, average maximum air velocity of 0.6 meters / second (regarding human body skin), will create a decent air temperature of 32.2^{o} C, As for the humidity of the air is 60%. The speed of air movement will be reduced, if the density of existing buildings on the edge or environment of a particular community is less or not addressed. The presence of a gentle breeze on buildings is a very important thing to consider in the process of laying out a layout in an urban area. Frequency, the presence of wind can be thought to be absent, when the calm periods occur.

In this idea the movement of air (wind) doubles as a component that directly enhances thermal comfort as well as a propeller driving element to draw air from a dense area to a gap. At certain height ranges the movement of air has a towering graph. Here is an illustration of the wind based on a variant of three conditions:

A= In a dense urban area

B = In less crowded suburbs

C = In rural areas that are still very quiet.

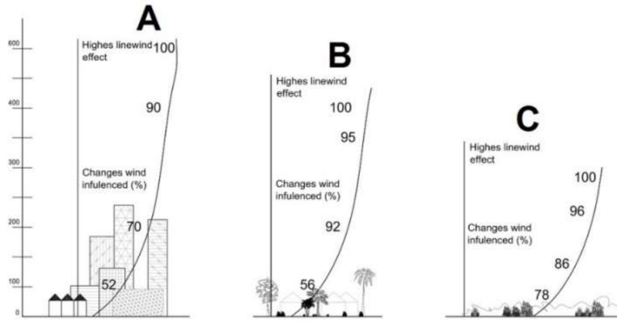

FIGURE 2. Illustration of wind strength based on variant situations [7].

Wind speed in Indonesia is an average of 0.6 meters / second, so if it is at an altitude of more than 4 floors the speed will increase to 1.6 - 3.3 meters / second, so that it can rotate the cyclone propeller. Here is a table that brings together wind speeds and the signs that result.

TABLE 1. Table of wind speeds and the signs that result [7].

The Strength of the Beaufort Wind	Wind Speed (m / sec)	Signs of Wind Speed	Wind Strength (kW / m^2)
0	< 0,2	Shady	-
1	0.3 – 1,5	Smoke starts to move	-
2	1,6 – 3,3	Leaves start to move	-
3	3,4 – 5,4	The twigs begin to move	0,021
4	5,5 – 7,9	Branch begins to move	0,08
5	8,0 – 10,7	Small tree starts to move	0,23
6	10,8 – 13,8	Telephone wires start to whistle	0,47
7	13,9 – 17,1	Difficulty walking against the wind	0,95
8	17,2 – 20,7	Tree branches began to break	1,75
9	20,8 – 24,4	Flying roof tile	2,27
10	24,5 – 28,4	The trees uprooted with it roots	4,75
11	28,5 – 32,6	Heavy damage to buildings	6,89
12	32,7 – 39,9	Rarely on land, occurs at sea	10,5

DISCUSSION

Core is a structural component of a building structure that is rigid and massive, continuously from the bottom up to the roof top deck or roof. In the context of the core structure has the main function to resist the lateral force (horizontal). The staff is a continuous vertical direction on each floor of a multi-story building with many main functions as a distributor of building utility networks including water installations, wave installations, electrical installations and so on.

In the context of a utility system for multi-storey buildings, temporary cores have the norm that is more functioned as a means of channeling the vertical direction for transportation, water flow, wave flow / strong current and weak electrical systems. With this idea intended to increase the treasury of core functions, namely as a medium of vertical air passage (towards the Outlet hole).

FIGURE 3. Making processing and final results of realized installation design with 2 Cyclone Configuration.

TABLE 2. Respondent statements when the cyclone was not spinning.

Statement Respondents Cyclone **Spin = 0**	Position and Condition of Toilets on Building Floors																																						
	13			12			11			10			9			8			7			6			5			4			3			2			1		
	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S
Respondent 1			v			v			v			v			v			v			v			v			v			v			v			v			v
Respondent 2			v			v			v			v			v			v			v			v			v			v			v			v			v
Respondent 3			v			v			v			v			v			v			v			v			v			v			v			v			v
Respondent 4			v			v			v			v			v			v			v			v			v			v			v			v			v
Respondent 5			v			v			v			v			v			v			v			v			v			v			v			v			v
Respondent 6			v			v			v			v			v			v			v			v			v			v			v			v			v
Respondent 7			v			v			v			v			v			v			v			v			v			v			v			v			v
Respondent 8			v			v			v			v			v			v			v			v			v			v			v			v			v
Respondent 9			v			v			v			v			v			v			v			v			v			v			v			v			v
Respondent 10			v			v			v			v			v			v			v			v			v			v			v			v			v

Legend:
- O = Odorless (2 pts)
- RS = Rather Stinky (1 pts)
- S = Stinky (0 pts)

TABLE 3. Respondent statements when 2 unit cyclones spins

Statement Respondents Cyclone Spin = 2	Position and Condition of Toilets on Building Floors																																						
	13			12			11			10			9			8			7			6			5			4			3			2			1		
	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S	O	RS	S
Respondent 1	√			√			√			√			√			√			√				√			√			√				√			√			√
Respondent 2	√			√			√			√				√			√			√			√			√			√				√			√			√
Respondent 3	√			√			√				√			√			√			√				√			√			√			√			√			√
Respondent 4	√			√			√			√				√			√			√			√			√				√			√			√			√
Respondent 5	√			√			√				√			√			√			√			√			√			√				√			√			√
Respondent 6	√			√			√			√			√				√			√			√			√				√			√			√			√
Respondent 7	√			√			√			√			√				√			√			√			√			√				√			√			√
Respondent 8	√			√			√			√				√			√			√			√			√			√				√			√			√
Respondent 9	√			√			√			√				√			√			√				√			√			√			√			√			√
Respondent 10	√			√			√			√			√			√				√			√				√			√			√			√			√

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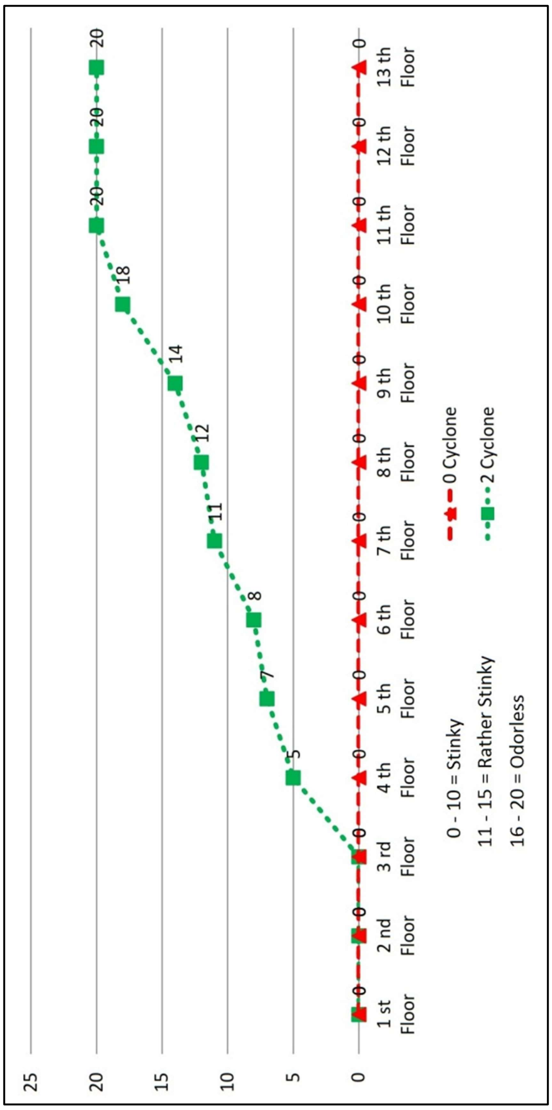

FIGURE 4. Chart Diagram of loss of stink after activation of 2 unit cyclones.

CONCLUSION

From the results of the analysis of the acquisition of field data shows that toilets without an exhaust fan (electrically powered) cause a foul odor and high relatifly humidity. The state of a closed toilet will cause a foul odor. The positive response to the stench in the room is the innovation of cyclone engineering while also acting as a supporter of the ventilation system in green architecture. With the use of wind-powered cyclone, the electrical energy used at the At-Tauhid Building, University of Muhammadiyah Surabaya will be reduced. After all the stages of making and installing the chimney and funnel cyclone as well as testing the use of cyclone, it is concluded:

- The installation of cyclone is considered quite optimal. This is proven by the presence of foul odors around 2 meters in the area of 2 cyclones located on the 14th floor (top deck) of the At-Tauhid Tower Building.
- Significant function of 2 cyclones only reaches up to 3 to 4 floors from 13 existing floors.

REFERENCES

[1] Hervé Pabiou, Julien Salort, Christophe Ménézo, Francesca Chillà “Natural cross-ventilation of buildings, an experimental study” 6th International Building Physics Conference, IBPC 2919 (2015).

[2] Santoso, Mas. *Climatic Design for Warm Humid Climates*. “Proceeding Tropical Architecture Workshop “. Editor : R. Aynsley, (1993).

[3] Lippsmeir, Georg. *Tropenbau Building in the Tropics*. Verlag Georg DW Callway. Munchen. (1989).

[4] Gunawan, Arifin MS. *Rumah Bercerobong sebagai Upaya Optimalisasi Ventilasi Silang* “Prosiding Seminar Nasional. Teknologi Ramah Lingkungan dalam Pembangunan Berkelanjutan” (Fakultas Teknik Sipil dan Perencanaan. Institut Teknologi Nasional Malang. (2010).

[5] Santoso, Mas. *Environmental Factors in Traditional Environment*. Rethingking Environmentally Responsible Architecture, A Case of Traditional Architecture in the Tropic of Indonesia. Editor : Nezar Al Sayyad. (International Association for the study of Traditional Environments) University of California. Berkley. (1996).

[6] Xiao-Yu Maa, Yue Penga, Fu-Yun Zhaoa, Cheng-Wei Liua, Shuo-Jun Mei, *Full Numerical Investigations on the Wind Driven Natural Ventilation: Cross Ventilation and Single-sided Ventilation.* 10th International Symposium on Heating, Ventilation and Air Conditioning, ISHVAC2017, (2017), p. 3803.

[7] Frick, Heinz dan Mulyani, Tri Hesti. *Arsitektur Ekologis* (Kanisius, Yogyakarta, 2006), p. 78.